The Science Teacher

Including

THE ILLINOIS CHEMISTRY TEACHER

Volume IV — MARCH, 1937 — NUMBER I

IN THIS ISSUE—

THE NEXT ISSUE, in part—

The Science Teacher

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VOLUME IV | MARCH, 1937 | NUMBER I

Crystalline Tobacco - Mosaic Virus Protein

W. M. STANLEY

Rockefeller Institute for Medical Research — Princeton, New Jersey

Editors Note: Our concept of a dividing line between living and non-living matter now appears in need of revision in view of recent research in the much disputed field of the so-called filterable viruses. The results of past work in this field have been uncertain and contradictory. Many have held to the existance of submicroscopic organisms so small as to pass through the finest filters. Others chose to regard each of these infectious agents, not as being bacterial in nature, but as "a contagious living fluid".

Doctor W. M. Stanley and his associates of the Rockefeller Institute for Medical Research recently attacked this problem. Much interest has centered in the results of their work because of Dr. Stanley's claim to the discovery of a protein which appears to bridge the gap between the living and non-living. At the December meeting of the A. A. A. S. at Atlantic City, he presented a paper describing the results of this research. With his permission, we are including a summary of this paper.

Because of the confused state of our knowledge, it was deemed advisable to confine our preliminary work to a study of the basic properties of some virus and, because of its ready availability, its high infectivity, and its stability, tobacco-mosaic virus was selected for study. The effects of many different chemical agents, of various enzymes, of intense sound waves, and of acid and alkali were studied. Perhaps the most important finding resulting from this preliminary work was the indication that virus was protein in nature. This definite information, plus improved methods for working with proteins recently made available through studies on crystalline enzyme proteins, soon led to the isolation from mosaic-diseased plants of a crystalline protein possessing the properties of the virus.

This crystalline protein contains 16.5 per cent nitrogen, about 50 per cent carbon, and 7 per cent hydrogen, and is optically active, having a specific rotation of -0.43 degrees per mg. of nitrogen. Although the crystals of the protein are small, averaging about 2 or 3 hundredths of a millimeter in length, they are true crystals since they are double refractive and give a regular crystalline pattern on X-ray analysis. The material gives the usual color reactions for a protein and does not give a test for carbohydrate When solutions of the protein are made more alkaline than about pH11 or more acid than about pH1, or are heated to about 75 degrees C., the protein is denatured and the virus activity is lost. The protein is not digested by trypsin, but is slowly digested by pepsin with loss of virus activity.

Perhaps the most unexpected findings were the large amounts of this material which occurs in diseased plants and the high molecular weight of this protein. It has been found that between 80 and 90 per cent of the total protein in well diseased Turkish tobacco plants may consist of this virus protein. Furthermore, the mosaic virus stimulates the plant to produce more protein, so that the extract of diseased plants may contain twice as much protein per cc. as the extract of normal plants. Dr. Sved-

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TOBACCO-MOSAIC (Continued)

(Continued from page one)

berg and Dr. Wyckoff have found the crystalline protein to have a molecular weight of 17,000,000, a value considerably larger than that of any other known protein. Mosaic-diseased Turkish tobacco plants contain, therefore, about twice as much total protein as normal plants, and from 80 to 90 per cent of this protein consists of the unusual, high molecular weight virus protein.

Now let us consider some of the properties of this material. Many tests have indicated that the virus activity of this crystalline protein is about 500 times that of the starting material. One cc. of a solution containing but 10^{-9} grams per cc. of the protein has usually proven infectious. Under favorable conditions solutions containing only 10^{-14} grams, or about 300 molecules of the protein per cc. of the solution have proven infectious. Since only a very small portion of a solution administered to a leaf actually comes in contact with susceptible cells, this may be regarded as approximating the maximum theoretical dilution of the virus protein.

The virus activity, chemical composition, isoelectric point, molecular weight, X-ray diffraction pattern, and optical rotation of protein obtained from many different lots of starting materials are the same. Furthermore, these properties remain constant on careful recrystallization of the protein, on fractional crystallization, or on fractionation by adsorption.

On the assumption of a spherical molecule, the molecular weight of 17,00,-000, corresponds to a protein molecule having a diameter of about 35 millimicrons. Although the protein passes a Berkefeld W filter, it is held back by collodion filters through which proteins such as egg albumin readily pass. Collodion filters which hold back the protein also hold back the virus activity. It has not been found possible to separate the virus activity from the protein by means of filtration through collodion or other types of filters.

Now let us consider the possibility of a relationship between this protein and the mosaic disease. The active protein just described was isolated from mosaic-diseased Turkish tobacco plants. It seemed of interest to determine whether the same or a similar protein could be found in normal plants. In several attempts, however, not even a trace of it could be detected in extracts from normal plants, although when a few milligrams of active protein were added to such extracts no difficulty was encountered in reisolating most of the added protein. Furthermore, no evidence for the existence of this high molecular weight protein in extracts from normal plants was obtained. It is concluded, therefore, that this protein does not exist in normal Turkish tobacco plants and that it is peculiar to the mosaic-diseased plants. Now it is well known that many different species of plants are susceptible to the mosaic disease. It seemed of interest, therefore, to determine whether or not other susceptible plants, including those distantly related to tobacco, would also contain this peculiar protein following infection with the mosaic virus. Tomato plants were first studied, and Dr. Loring found it possible to isolate this same high molecular weight protein from mosaic-diseased tomato plants. I have been able to isolate either the same or very closely related high molecular weight, crystallizable protein from mosaic-diseased spinach and from mosaic-diseased phlox plants. The protein isolated from tobacco or tomato plant. Dr. Beale announced that she had been able to obtain this crystalline protein from still other plants such as petunia. The isolation of identical or closely related high molecular weight proteins from mosaic-diseased Turkish and Burley tobacco, tomato, spinach, and phlox plants, and the failure to find the material in normal plants indicate that this unusual protein always accompanies and may be characteristic of the mosaic disease.

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TOBACCO-MOSAIC (Continued)

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Now let us consider whether this material is simply a characteristic protein produced as a result of the virus disease, and thus always accompanying the virus, as, let us say, a pathological protein, or whether this material actually represents tobacco-mosaic virus. If it could be proven that the material is entirely pure and consists of only one molecular species, then it would folow directly that the protein is the virus. It is necessary and advisable to admit at the very start the possibility that the crystalline tobacco-mosaic virus protein may be impure and consist chiefly of inert protein plus an amount of active virus agent which possibly may be too small to detect chemically. However, if the virus exists as an impurity in the protein, its amount must be very small. In view of the dilution which the protein will stand and still retain activity, it seems highly improbable that the presence of a few hundredths or even a few tenths of a per cent of an impurity having a molecular weight greater than that of the protein could account for the virus activity.

However, because of the importance of the virus problem and because many individuals have taken refuge in the impurity idea, it has been deemed advisable to consider the question further. The unusually high molecular weight of the protein permits a new and powerful attack to be made on the problem, for it enables the protein to be removed selectively from solution by centrifugal force. If the virus activity is a specific property of the protein, then following centrifugation of different amounts of protein solutions at different hydrogen ion concentrations or from solutions containing other proteins, the virus activity of the supernatant liquids should be dimished and be proportional to the amount of high molecular weight virus protein that they contain. If, on the other hand, the virus activity should be due to an impurity adsorbed on the protein, it seems probable that following centrifugation, the virus activity of the supernatant liquids would not be proportional to their high molecular weight protein content. Centrifugation of the protein from solution should seperate it from the impurity. When this was done however, the virus activity of the upper and lower portions of solutions of virus protein centrifuged at pH 2.4, 6.7, and 9.4 was exactly proportional to the amount of high molecular weight protein that they contained. This proves that under various conditions the virus and the protein sediment at the same rate and that they are the same size, and indicates, therefore, that they are identical. The fact that the crystalline protein from many different batches of starting material has the same chemical composition, isoletric point, optical rotation, and biological activity, and that these properties remain constant during many recrystallizations and following drastic fractional crystallization, the fact that it was found impossible to separate the activity from the protein by means of filtration through collodion or other types of filters, or by centrifugation of the protein from solution under a variety of conditions, the homogeneity of the protein with respect to size and isoelectric point, the isolation of the protein from plants distantly related to tobacco, the isolation of different proteins from plants diseased with different strains of tobacco-mosaic virus, and the fact that any change in the protein is accompanied by a change in virus activity are all indications that the virus activity is a property of the protein. In view of the complete absence of any contradictory evidence, I feel that the results fully justify the conclusion, for the present at least, that this unusual, high molecular weight protein is actually tobacco-mosaic virus.

Now, let us examine some of the implications of this conclusion. Since tobacco mosaic, the first virus to be discovered, has long been considered to be a representative virus, it seems likely that other viruses may be found to be proteins. It may be permissible, therefore, to speak with a moderate degree of

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John C. Chiddix — Editor and Business Manager
Normal Community High School, Normal, Illinois
P. K. Houdek — Assistant Editor
Robinson Township High School, Robinson, Illinois
W. Glen Tilbury — Advertising Manager
Urbana High School, Urbana, Illinois
S. A. Chester — Asst. Advertising Manager

CONTRIBUTING EDITORS

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Howard W. Adams — Illinois State Normal University
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John C. Hessler — James Millikin University, Decatur, Illinois
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OUR JOURNAL

With the recent official endorsement of this Journal by the Illinois Biology Teachers' Association as the official publication of their organization we are committed to the policy of serving teachers of both the physical and biological sciences. This seems to be a logical as well as practicable step, for a preliminary survey of science teachers show that in the average high school fully 80 per cent teach more than one science. Hence a journal of this type can best serve by bringing the discussions and work of the different science associations. Its policy shall continue to be to bring the best thought, the newest ideas, progressive methods, and special helpful material in the science field and to present it in a concise form condensed to a minimum of space commensurate with the facts presented. Constructive criticism will always be much appreciated.

It should be remembered that this publication is the work of associations of science teachers and as such provides the opportunity for teachers to obtain the type of service they desire. If you are interested in this work, write in and tell us, tell us what you are doing that is different, and also tell us of those who are doing something well or new. Make your relation to this Journal a personal one, for only by closely working together can we accomplish the most in our profession.

SPRING MEETING OF ILLINOIS ASSOCIATION OF CHEMISTRY TEACHERS

From all indications the regular Spring meeting of the Illinois Association of Chemistry Teachers coming April 3 at Normal, Illinois promises to be an interesting one. The program as outlined by Professor George C. Ashman of Bradley Polytechnic Institute, President of the Association, will include men from high school, university, and industrial field.

Professor Howard Adams of Illinois State Normal University will have charge of local arrangements including the morning field trip to the Williams' Oilomatic plant in Bloomington and the noon luncheon at Fell Hall. Those who have been to the Oilomatic plant and have witnessed the demonstrations given, state that the visit is quite interesting and very educational.

Plan to come early and do not forget that both the field trip and the luncheon offer splendid opportunities for getting acquainted with your fellow teachers.

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That Science Club

MABLE SPENCER

Community High School Granite City, Illinois

The hundreds of thousands of boys and girls graduating from our high schools each year make us cognizant of the fact that unless each of these develops his own personality traits, his own leisure interests, he is apt to be a sordid cog in a soul crushing machine age, the prey of any agitator.

This is the scientific age, even the strongest classicist recognize this fact. The question is "How can the teacher of to-day, burdened with duties as he is, meet this situation?" The student keenly alive with scientific interests must be helped, otherwise few great scientists will have opportunity to develop. The biographies of most of our great scientists are records of the fact that scientific curiosity cultivated as a child has been the backbone for many truly great scientific careers. Irving Langmuir's hero worship of his brothers Chemical education advances made him a student at the age of nine or ten. Our own students are made to enjoy the spirit of science or they are made to abhor all scientific terminology.

Many high school administrators have been driven by lack of foresight or economic handicaps to minimize the possibility for ordinary classroom inspiration. The science club in some form or other may be made to be the teacher's instrument of success. In the club one may have a select group. They may be selected either by scholastic attainments or by scientific interests. A camera club may not study photography only but the making of pictures of industrial processes, chemical apparatus, science in nature and color photography. A chemistry club may study hundreds of things, such as plant processes, electro-plating, crystal formation, agricultural products, model making, mirror making, etching, mineralogy, chemistry of photography, dyes, and tanning. Biographies of many of our favorite chemists are as exciting reading as any fiction. These may be presented in playlet form, in tableaus, or as individual reports.

The science club gives opportunity for many things which a larger group can not do in the limited time of the school period. Many community speakers can be secured in the evening which could not be secured during the regular day. The city water plant, the local news plant, an ice company or any nearby industry would be pleased to welcome a group of students interested in science at work.

Many of our nationally known advertizers offer scientific movies to schools, not only furnishing the films but the machines and operators. Among the many who perform such services are: Ford Motor Company, General Motors, Eastman Kodak, and Beechnut Packing Company. The University of Illinois offers a film service and the United States Navy has films of Travelogue type which are very good.

The Illinois Junior Academy of Science offers especial aid to science club sponsors. It offers many types of service among which is its Science Service Leaflet which has ideas for club organization, club activities and regulations for our annual contests. Each year the Jr. Academy through the courtesy of the University of Illinois station offers a radio series. The theme for this year is "Opportunities in Science". These are broadcast each Saturday afternoon at 4:30. Our annual competition is held in connection with the meeting of the Illinois Academy of Science and will convene at Rockford, Illinois, on the 7th and 8th of May. Contests will be held in chemistry, geology, physics, biology, general science. In addition to these there are contests in news letter writing and radio notebooks. Any sponsor or prospective sponsor is invited to partake of the opportunities which the Acadmey offers.

Biology Notes

P. K. HOUDEK

Robinson Township High School Robinson, Illinois

TO MEMBERS OF THE ILLINOIS BIOLOGY TEACHER'S ASSOCIATION

Perhaps you will be a bit surprised to receive this copy of THE ILLINOIS SCIENCE TEACHER. It is not a sample copy. You will not get a bill for it. You will receive four issues this year as a part of your membership in our Association.

Last fall we received an invitation from The Illinois Chemistry Teachers' Association to join them in their publication, then THE ILLINOIS CHEMISTRY TEACHER. They offered to change the name to the present one.

At our meeting last November a motion was made and carried that a committee consisting of the past presidents be appointed to investigate the offer. This committee was given the power to act for the Association. The investigation was made. The offer was good. The NEWS LETTER of our Association was discontinued Our new president, Mrs. Grace L. Cook of Champaign, has appointed Mr. P. K. Houdek of Robinson as biology editor representing our Association. Other contributing editors from the field of biology will be appointed in the near future. We want your comments, suggestions and helps. "Letters To The Editor" are in order.

Biology Curriculum Committee

The High School Visitors Office of the University of Illinois is making progress in the study of curriculum. The general plan is for the improvement of instruction through a study of aims, methods, content and coordination with other subject areas. The plan calls for a study curriculum by teachers actively engaged in teaching. At the suggestion of Mr. A. W. Clevenger, High School Visitor, a committee was appointed in the biology section of the High School Conference to aid in selecting a committee for the studies indicated. The following teachers were suggested, approved by the High School Visitors office, and an advisory committee from the Illinois Principals Association.

1. Mrs. Olive Nuttall, Springfield High School.
2. Miss Opal Hartline, Centralia Township High School.
3. Mr. Louis Astell, University of Illinois High School.
4. Mr. W. M. Bailey, Southern Illinois State Teachers' College.
5. Mr. Wesley Heinz, Mendota High School.
6. Miss O. Ruth Spencer, Moline High School.
7. Mr. Wesley W. Minear, Quincy High School.
8. Mr. P. K. Houdek, Robinson Township High School.
9. Mr. M. C. Lichtenwalter, Lane Technical High School, Chicago.

This committee will meet in the near future to organize and plan agenda for the future.

Mr. F. C. Hood, Assistant High School Visitor, is in charge of this and the various other curriculum committees that will soon be at work in this state.

Keeping Up

Have you read in the September 1936 issue of the Readers Digest the article "Man, the Unknown?" This article was condensed from the book by the same name written by Alexis Carrel and is undoubtedly one of the outstanding contributions to the understanding of the functions, operations, and relations of the various parts of the human body including the glands.

In December 1936 and January 1937 issues of the Hygeia, Milton Silverman, science editor of the San Francisco Chronicle, presents an interesting discussion of the microbe in relation to man, pointing out particularly its surprising usefulness. In the December issue appears "Microbes: Servants of Medicine" and in the January, "Microbes Versus Disease".

Objectives in Teaching Biology[1]

M. C. LICHTENWALTER

Lane Technical High School — Chicago, Illinois

Introduction: The purpose of this report is to present a suitable group of objectives for teaching biology. The objectives selected conform to the general aim of education—"Life enrichment through participation".

Major Premises: The committee desires to include three major premises which they feel are essential to this problem and are needed to clarify their report.

The First Premise: Pupils entering high school should have had training of a biological nature in the elementary school.

Secondly: Pupils in their first year of high school will be required to study a year of general science. This course, according to most authorities, should devote half the time to a study of material content of a biological nature.

The Last Premise: The study of biology will be for the high school pupil of at least the tenth grade level. The classes will for the most part include pupils of the adolescent age of development.

Regulatory Principles for the Formulation of Teaching Objectives For Biology: The following principles were used by the committee as a rule and guide in the formulation of the objectives.

(1) There is a deluge of available biological material of a factual nature suitable for illustrating principles to be used in the biology course. It is not a question of what will be used to best illustrate these principles. but which part of the desirable material must be eliminated because of a lack of time for its consideration in the course.

(2) There is nothing sacred about any phase of available material which might be included in the biology course. No material should be included which does not contribute to the objectives ot either education, science teaching, or biology. On the other hand, material should not be excluded simply on the basis that it is perhaps thread bare due to repetition and long continued usage.

(3) It is impossible to present the student with all the total life situations of a biological nature which he will encounter. Hence, representative and nearly typical life situations should be presented with the expectation that these will have been an aid in the solution of such life situations later.

(4) Methods for the presentation of subject matter are not mentioned in the objectives.

(5) The organization of the subject matter is also independent of the general objectives.

(6) Since the pupil has already received a certain amount of biological instruction before he reaches the Biology course, there should not be a duplication of such material.

(7) Recognition should also be made of the physiological and psychological changes in the pupil which are taking place during the time they are studying the Biology course.

(8) The objectives formulated should be a composite of the various systems of thought which are now prevalent together with the interpretation of such with the combined experiences of the committee. Furthermore, the objectives should be independent of the outline of any particular textbook, syllabus, course of study or curriculum study and should be the composite of the best and most desirable features of each.

General Objectives for Teaching Biology: The following statements may be considered as the philosophical attitude of the committee toward biology, as well as a set of general objectives.

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1. A paper read by Mr. Lichtenwalter before the Biology Center of the North Side High School, Chicago, December 1936. It is the aim of the group to perfect a biology course applicable to the schools of this section. The formulation of a set of suitable objectives is the desire of the group before beginning the work. Other members of the committee on objectives were Mr. J. S. Gammertsfelder and Mr. O. F. Kahle all of Lane Technical High School.

Combined Courses in Chemistry and Physics

S. R. WILSON

Northwestern High School Detroit, Michigan

Thirty years ago there were only about 500·000 pupils enrolled in our public high schools. Today, the number exceeds 4,000,000. This means an 800 per cent increase, a truly remarkable growth. But, as the numbers increase, the average ability decreases. In years past only a few went to high school and they were, as a rule, well qualified. Today the sons and daughters of our average citizens are crowding into our secondary schools.

Formerly the chief aim of our high schools was to prepare for college. In every subject the teacher had to keep this aim contiually in mind. Discipline and preparation for advanced study were the watchwords that had to be observed at all times. Our science courses were no exception to the rule. In chemistry the pupil had to understand valence, balance equations, and solve problems. In physics he had to apply mathematics, and he was expected to have some knowledge of mathematics to apply.

But conditions have changed. The high school is no longer just a preparatory school. For the great majority it is the finishing school. Evidently our curriculum should be changed, and this is what educators throughout the country are doing. In Detroit we are trying to solve this problem and, after about five years of experimental work, we have developed among other things a combined course in chemistry and physics.

This course aims to offer:

1. A unit in science for the "general" student.

In the Detroit high schools, the pupils are classified as college preparatory, commercial, or general. Before graduation all students must complete one unit in science. To meet this requirement, the college-preparatory student must elect one of the laboratory sciences—biology, chemistry or physics; but pupils in the general group may choose two half-year courses in science. Some principals recommend that Descriptive Chemistry be taken first. This may be followed by Descriptive Physics or some other one-semester science.

2. A survey or vocational guidance course.

The average high school student makes few future plans. He has little knowledge of occupations in general and less of the kind of work he is fitted to do. Chemistry to him means bad smells and explosions; physics means something disagreeable or something difficult. This course presents many practical applications of these sciences and, under the guidance and inspiration of a live teacher, some of the pupils will wish to continue. In fact we have found that Descriptive Chemistry and Physics act as "feeders" to the regular laboratory courses.

3. General information about the importance of science.

The safety of our democratic form of government depends upon the education of our citizens. The voter should know something about the sources of our wealth as a nation. What are our natural resources? How have they been developed? Are they being used wisely or are they being wasted? Of what importance is scientific research? What has science done for us in our homes and for industry in general?

These are some of the questions that are answered in this course. Certainly no subject taught in our high schools can contribute more toward making intelligent citizens than do chemistry and physics. To science teachers the truth of this statement is evident, but to the

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average individual these sciences are rather abstract. He may realize their importance in a vague way, but their "bread and butter" value has never been brought home to him. He does not realize that without chemistry and physics our present civilization would be impossible. As science teachers we should spread this information, and we feel that our combined courses in chemistry and physics is developing an appreciation of the fact that these sciences are closely related to our everyday living.

Fundamental Principles come first:

Chemistry and physics are so closely related that it is practically impossible to separate them. We usually label certain topics "chemistry" and others "physics". Oxygen and nitrogen, for example, are studied in chemistry, but, before we can explain their commercial preparation, we must teach some physics. Cells and batteries, on the other hand, are studied in physics but, to understand their action, we must know some chemistry. Formerly the physicist was chiefly concerned with energy and the effects produced when force was applied to movable objects. He was willing to stop with molecules and leave the atoms to the chemist. Today the conditions are different. We learn that matter is being transformed into energy, and the physicist spends much of his time studying the structure of the atom.

Organization:

For practical reasons, however, we have divided our combined course into two sections. In many parts of the country administrators are feeling the need of more half-year electives in science, especially for pupils in the general course. To meet this need we offer our two courses, Descriptive Chemistry and Descriptive Physics. Some prefer to give a full year's work in physical science. For this course the two sections are being combined in a single text.

While our chief aim is to develop an appreciation of the importance of science, we have tried to avoid the mis- out including the fundamental laws and take of attempting to teach science with- principles. Every instructor knows the folly of this procedure. To discuss a large number of unrelated facts gets nowhere. As a result neither the teacher nor the pupil is satisfied.

In this course we emphasize fundamentals. As a rule we first perform some simple experiments to demonstrate the principle we are trying to teach. Following this we give several practical applications. In selecting this illustrative material we keep in mind the interests of the pupil. We bring the subject home to him. We make him see that these principles of chemistry and physics are being applied on all sides.

We have, however, tried to avoid being too technical. Many of the principles of chemistry can be taught without balancing equations and solving problems. Pupils who do not take advanced work in science soon forget valence, formulas, and equations. But they do not forget the laws of nature when they have once learned to observe them in action, nor do they lose the scientific attitude when they have developed the habit of collecting all the available facts before making decisions.

This combined science course tends to develop these desirable attributes. The fundamental principles and laws are stated in simple English; the explanations are clear and convincing; the applications are up-to-date and closely related to the pupil's everyday experience. One good way to develop the scientific attitude is to study the lives of the great men of science. Beginning with the time of the alchemists when superstition and religious prejudice were everywhere prevalent, the relation of science to the progress of civilization is traced through the ages. When the student learns that only a few generations have passed since Roger Bacon was imprisoned for pre-

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Summer School Courses for the Secondary School Chemistry Teacher

D. G. NICHOLSON

University of Illinois Urbana, Illinois

Secondary school teachers who are working, or who plan to work, on advanced degrees during summer vacations often find some difficulty in selecting courses in which they will obtain graduate credit and, at the same time, be of benefit to them in their daily teaching.

In an attempt to relieve this situation the chemistry department of The University of Illinois has added certain courses to its summer school curriculum which should have definite appeal to the secondary school teacher who plans to attend the 1937 summer session. These courses aim to give the students general information of non-technical, non-mathematical character, as well as a review of recent trends in chemical development, theories, and teaching practice. Graduate credit is given in each of the following courses (with the exception of S-17) which will be offered in the summer session of 1937.

Chemistry S-17 is a course entitled "Methods of Teaching Elementary Chemistry in the High School". This course includes a study of the problems encountered in teaching chemistry. Round table discussion, assigned readings, and reports dealing with special problems and topics will be taken up. At least a year's experience teaching in high school or the consent of the instructor are given as prerequisites. Professor B. S. Hopkins will meet this group four times a week. Three hours graduate credit are given in this course.

Chemistry S-107 is entitled "Recent Developments in Inorganic Chemistry". This course presents a study of the recent advances which have a bearing on the theoretical and descriptive material in general and inorganic chemistry. It is designed particularly for the high school teacher. It will consist of lectures, reports, and assigned readings. Graduate standing in chemistry and the consent of the instructor are given as prerequisites. Professor Hopkins will meet this group four times a week. Three-quarters unit graduate credit will be given in this course.

Chemistry S-120 is entitled "Survey of Modern Analytical Chemistry". It will meet four times a week with Professor G. L. Clark in charge. The course material will consist of a study of general chemical reactions; methods, theory and practice of modern qualitative and quantitative analyses. Lectures based upon the theory of solutions and other fundamental concepts of equilibrium and ionic activity will be taken up in some detail. Graduate standing with undergraduate training in qualitative and quantitative analyses are given as prerequisites in this course. Three-quarters unit graduate credit is given those who take this course.

Chemistry S-131 is entitled "Recent Developments in Organic Chemistry". The primary purpose of this course is to enable the students and teachers of chemistry to become acquainted with the newer developments which have taken place during the last five years, and which have not, as yet, found their way into textbooks. The course will consist of lectures, discussions and reports covering articles found in recent chemical literature. Professor R. L. Shriner will meet this group four times a week. Three-quarters unit graduate credit will be given in this course.

Chemistry S-146 will be offered under the title: "Nuclear Chemistry, Valence, Atomic and Molecular Structure". It includes a review of recent work on the structure of the nucleus, isotopes, ultimate particles, and nuclear transformations involving neutrons. The course is

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Demonstration vs. Laboratory Teaching

GEORGE D. BAIRD

Rock Island Senior High School Rock Island, Illinois

On the subject of CLASSROOM DEMONSTRATION VERSUS INDIVIDUAL LABORATORY PRACTICE, much has been said concerning the merits of each as an aid in the teaching of chemistry. Before offering my opinions, I wish to say that as a teacher of chemistry I realize the subject under discussion is as broad in its scope as the aims and ideals of the various teachers.

I have drawn the following conclusions: the relative merits of these two methods cannot be determined by the experimental practices thus far employed. The two main faults of these methods are, first, the failure to control all factors involved; second, the emphasis placed upon the mass of factual material retained by the student as the supporting evidence of the experimenter's conclusion.

This belief is a result of five years of experimentation with classes in which I atempted to control every factor that might in any way influence the results. I found it impossible to control all factors so that a true value could be placed upon the results obtained. During this same period I studied the work of many others and, using the same measurements, I did not find one case that I considered as conclusive evidence for either side. As a result of these findings I discarded the entire work. Others interpret the evidence differently, for there are many dissertations published which are cited as proof of the advantage of one method over the other.

For the purpose of discussion, let us accept as a fact that all factors may be controlled, thus securing correct data. We still have to consider the fact that in all of the experiments conducted the evidence and conclusions have been based upon how great a mass of factual material has been retained by the student, rather than on some of the more vital aspects of education. Useful citizenship, ability to think and to be able to evaluate between facts and propaganda are some aspects which I consider superior to subject matter.

It has been my experience that both methods have their place in our chemistry classrooms today. One cannot supplant the other, as each has its own contribution as a teaching aid. There are one or two points, however, that I think we should consider before we use the conclusions derived from tests of purely subject matter retention. We all recognize that laboratory procedure is of little value unless it is well directed and supervised. Class demonstration cannot accomplish the desired results unless it is also well directed and supervised. Too often with classroom demonstration the instructor carries out the work without careful preparation. This may be due to overloaded teaching schedules or to the lack of proper skill on the instructor's part.

To the administrator who is interested in cost and teacher distribution, classroom demonstration may be readily interpreted as securing just as good factual results as the more expensive and time consuming laboratory practices.

The present tendency of educators to emphasize the fact that our schools must endeavor to make good citizens of all students and not cater to the select few, makes it imperative that we consider the number and type of students reached by the two different methods.

The better student will derive just about as much benefit from classroom demonstration as from laboratory practice. He is the one who really gets laboratory practice in doing the demonstration work for the class. He is able to solve his problem by using the experience of others. He is better able to develop his own reasoning ability from the data and conclusions of other investigators.

The majority of our students in high

(Continued on next page)

Preliminary Announcement of Program
ILLINOIS ASSOCIATION OF CHEMISTRY TEACHERS
Illinois State Normal Unversity
Saturday, April 3, 1937

Morning—

10:00 Field trip to Williams' Oil-O-Matic Heating Corporation plant of Bloomington, Illinois, on U. S. route 150. Meet at the plant.

12:45 Luncheon at Fell Hall, Illinois State Normal University. Cost is 50 cents. Write Professor Howard Adams, Normal, Illinois, for reservations. Late reservations are not possible.

Afternoon—

1:45 Afternoon meeting, room 105, David Felmley Hall of Science.
Chairman, Professor George C. Ashman, Bradley Polytechnic Institute, Peoria, Illinois.
Business, including the election of officers.
Micro Methods in Chemistry. Professor J. H. Reedy, University of Illinois, Urbana, Illinois.
The Utilization of Gas from Activated Sludge of a Sewage Disposal Plant. L. S. Kraus, Peoria, Illinois.
Photography as an Extra Curricular Activity. M. E. Woodworth, Principal of Pittsfield High School, Pittsfield, Illinois.
Photography as an Extra School Activity. J. H. Sammis, Central High School, Peoria, Illinois.

Membership. Your dues to the Illinois Association of Chemistry Teachers may be sent to Mr. S. A. Chester, Secretary-Treasurer, Bloomington High School, Bloomington, Illinois. It is easier to send $1.00 for two years, as a number are doing. Membership in the association brings you The Science Teacher without further cost. Our goal is EVERY CHEMISTRY TEACHER OF ILLINOIS AN ACTIVE MEMBER.

DEMONSTRATION vs. LABORATORY

(Continued from page 11)

school are not in this group. Many of our slow and most of our problem students in academic work come from the so-called lower mental level. It has been shown many times that this group is often superior in manual skills and also when they can actually develop and solve their own problems by actual practice. If a student has failed consistently in academic work, he is very often placed in the manual arts department in an endeavor to train him to do something useful.

When we consider the merits of the two systems from this viewpoint, it is only logical in my opinion that to eliminate the laboratory from chemistry is to eliminate the opportunity for all students to develop their abilities to the fullest extent. If the laboratory procedure is well directed, the more able student will develop faster and secure at least as much factual material as the most ardent classroom demonstration advocate could desire. The less able, or that group representing the majority of our school, will be provided for in at least one academic subject. Sometimes the individual, who has been considered a problem, agreeably surprises both the administrator and the instructor if given his opportunity.

conclusions are as follows:

1. "Studies reported in the literature comparing the lecture demonstration method with the individual laboratory method are in the main not statistically significant, but seem to be favorable to lecture demonstration."

2. "The study here reported, involving twelve sections of first year college chemistry students, has not produced uniformly significant results."

3. "It seems reasonable to conclude, on the basis of several methods of comparison and on the number of students used, and the number of colleges and instructors involved, that these students made better progress, as that progress is

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Science in 1936

S. A. CHESTER

Bloomington High School Bloomington, Illinois

In the magazine Science, Science Service lists the following as notable events in the field of chemistry during the year 1936.

In relation to foods are discoveries concerning vitamins, enzymes, and the preservation of milk. Vitmain B1 which prevents beri-beri was artifically produced by Dr. R. R. Williams and associates of Columbia University and the Bell Telephone Laboratories and Dr. J. K. Kline of Merc and Company.

Those highly complex proteins, enzymes, that make possible digestion, body oxidation, and other physiological processes can now be formed out of inactive proteins by suitable chemical changes and heating according to the report of Dr. J. H. Northup of the Rockefeller Institute for Medical Research. Also a chemical compound containing an enzyme as one of its components was discovered by Dr. Kurt G. Stern of Yale.

According to a new process milk may be preserved for several months by packing it under pressure with oxygen and shipping it refrigerated.

Casein from milk was used to produce a synthetic substitute for wool, but the fiber so produced has been shown by tests to lack the strength and stretching characteristics of the natural material.

From corn starch was made an explosive known as hexanitioinositol which is more powerful than nitroglycerine. It was reported by Professor Edward Bartow, president of the American Chemical Society. Also in the field of explosives was developed a unique powder that is both smokeless and flashless. Credit for this new invention so desired by military men goes to R. G. Woodbridge of the E. I. duPont de Nemours Company, Wilmington, Delaware.

Fuels also were given attention. Oil and gasoline were made from coal at an experimental plant in Pittsburg by the U. S. Bureau of Mines. Further conservation of gasoline as well as help for the farmer may be seen from the efforts of the Chemical Foundation which sponsored the establishment at Atchinson, Kansas, of the first alcohol plant for the manufacture of power alcohol for blending with gasoline as a motor fuel. In the

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INDIUM

Reviewed from Scientific American

Once again an element which heretofore has been merely a name and number in the periodic table, is becoming a tangible and useful article of commerce. The element indium, discovered by Ferdinand Reich and Theodore Richter in 1863, remained until 1934 a chemical curiosity. Then William S. Murray of Utica, New York, president of the Indium Corporation of America and a pioneer in the recovery and development of this metal, was able to display 250 ounces of it.

Indium is a metal aristocrat. It is softer than lead, lighter than zinc, more lustrous than silver and as untarnishable as gold. When alloyed with copper or silver, indium becomes an ideal metal for jewelry. When it is added to bismuth, lead, tin and cadmium, an alloy is formed having a melting point of 116 degrees Fahrenheit.

Sidney J. French of Colgate University lists some interesting uses for such an unusual alloy. Because of its low melting point, it may be used to take impressions of the features of living persons. When made of this alloy, surgical casts may be made and removed with little difficulty. Naturally, it can be of considerable value in the making of automatic fire sprinkler systems. It may also be used as a spray to provide a metal coat for works of art. When soft, it may be worked into relief figures with the bare hands. When one desires to engrave its surface, a warm pen is the only tool needed.

Starting a Science Club

BLANCHE McEVOY

Illinois State Normal University Normal, Illinois

In the sprng of 1935 the Illnois State Academy of Science met in Bloomington, Illinois. Those in charge of the Junior Academy invited the University High School at Illinois State Normal University to put up some exhibits at the Bloomington High School. Some of the biology pupils took their projects to Bloomington. We were not in the exhibit for prizes but we felt that our exhibits were as good as many others from other high schools. The meetings and the exhibits from other high schools were a great inspiration to our pupils who were interested in science, so that after the meetings, they insisted that we organize a science club. Consequently, in the spring of 1935, the Major Powell Science Club of the University High School came into existence.

We agreed that the club would be largely a club for work on projects, and that each person who became a member should carry on his project on his own traction, coming to the sponsor for help from time to time but never depending on the sponsor for complete direction of his project.

Much work has been done in the year and a half that we have been operating. Last year one member mended and cleaned some mounted birds and made a fine set-up for the biology laboratory.

This year we have added a radio group to the club. The leader of this group is Donald Brickey, who is a senior in the University. He is an amateur sender and has been an excellent leader. He has ten boys now in the group. Most of these boys have made radios that work. Now Mr. Brickey is training the group in the theory of radio. This work had afforded a fine chance for Mr. Brickey to get training in club leadership and this training should be of great help to him when he goes out as a high school teacher.

Several boys are studying rocks and classifying them. Mr. Holmes of the University faculty has given these boys valuable help. One boy is making an enlarged relief map of the Lake Louise region and is using a small contour map as a guide. Last year a junior boy began to work on reptiles. He has classified many of the preserved reptiles belonging to the university; he has made a study of reptile skulls and now is trying to make skulls that would do for museum specimens. A university senior, Carl Whitehouse, is working with two members of the club on molds and bacteria. One boy is working on animal micro-organisms, another on photography; one girl is working on stars; another girl is working on birds; and one boy is making a model airplane.

Another thing that the club has done is to sponsor talks. The club has had Mr. Charles Morrison, who is president of the world's largest amateur radio club, and Mr. F. E. Fuller who talked on corn hybrids. One club member gave an illustrated talk on Lake Louise.

Our meetings are from 6:30 to 8:00 p. m. on Thursday, but many of the club members work after school and on Saturdays.

It has been very evident that high school pupils **want to know things** and **want to learn to do things,** and it is certain that all high schools should give their pupils a chance to express themselves in project work.

SUMMER SCHOOL COURSES

(Continued from page 10)

intended to familiarize teachers in chemistry and chemical physics as may be understood without extensive mathematical preparation. Three-quarters unit of graduate credit will be given those who meet with Professor W. H. Rodebush in this course four times a week.

Chemistry S-162 is entitled 'Modern Chemical Processes". This course covers a non-mathematical discussion of recent industrial developments in inorganic

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Fur Tanning as a Project

JOHN C. CHIDDIX
Community High School AND Normal, Illinois
S. A. McEVOY
Senior High School Rockford, Illinois

A very practical and enjoyable project consists of tanning hides for making furs. With reasonable care, the product will equal commercially tanned fur in quality. Tame rabbit and muskrat hides and small pelts are readily tanned and made into beautiful articles for wear as well as to sell. The tame rabbits and muskrats may be raised as a profitable avocation.

If one will think for a moment of all the fur coats, mittens, gloves, caps, coat and dress trimmings now worn and highly prized for their beauty, he will the more appreciate the possibilities of this project.

The success of tanning depends upon changing the colloidal nature of the skin so as to preserve it and to cause it to hold the hair permanently. The change desired is necessarily slow and for the best final product requires several months, although a fur can be finished quite well in a week.

Preserving the Hide Until Tanning

If it is desired to keep a hide for some time before it is tanned, it is thoroughly salted and neither permitted to freeze nor heat before tanning.

Preparing the Hide

Before tanning, the hide should be clean, free from grease and flesh and quite flexible. If the hide is dry and hard, it should first be soaked in clean water until it begins to soften and then worked by pulling it back and forth on the flesh side over a smooth beam until quite pliable. The flesh side is then scraped with the back of a knife or a dull edge until all fat and flesh has been removed. All the shiny tissue that is left on the flesh side of a hide as it comes from the animal must be removed to make the tanning process more effective. Whenever a knife must be used, much care should be taken so as not to cut holes in the hide or expose the roots of the hairs.

After the skin has become quite soft and in good condition, it should be washed in good soapy water containing about an ounce of borax to the gallon. If the skin is still oily, it may be dipped in cleaner's naphtha. The fur side may be dried with corn meal, bran, or sawdust.

Salting Process for Preparing Furs

The salt process of tanning furs is very simple and may be carried out by any one. In this process the hide is soaked from 24 to 48 hours in a solution of salt and sulfuric acid. A solution of the following composition is suitable for rabbit, muskrat, or similar pelts.

Sulfuric acid, con., C. P.	20 cc.
Sodium Chloride	1000 grams
Distilled or rain water	4000 cc.

The salt may not all dissolve until the sulfuric acid has been added. A heavy hide will take more sulfuric acid and less water. The water may be varied from 3000 to 4000 cc., and the sulfuric acid from 15 to 25 cc., according to how thick the hide is. A hide that has had a preliminary treatment with ashes will require the full 25 cc. of acid as a part of the acid is consumed in reacting with the carbonate of the ashes.

Soaking in the acid salt solution causes the hide to swell. It is then soaped on the flesh side with laundry soap and rubbed until the soap is rubbed in well. Then it is folded with the flesh sides together and allowed to remain until the next day. After it has become nearly dry, the flesh side should then be washed thoroughly and the pelt stretched out to dry.

Before the skin is dry, it must be worked over a smooth round edge like a broom stick in the same way as a cloth is used in shining shoes. The working must be done repeatedly while the skin

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OBJECTIVES IN SCIENCE TEACHING

(Continued from page 7)

I. A sufficient amount of factual information of a biological nature should be acquired by the individual to permit him to comprehend important principles of biology.

II. There should be a clear understanding of fundamental principles of biology so that correct conclusions may be reached in comparable life situations of a biological nature and so that superstitions or erroneous beliefs may be dispelled.

III. There should be created such a desirable attitude toward biology that an urge to pursue some phase of it as an avocation will have been created.

IV. A reading skill in the field of biology should be developed so that the individual will be able to place a logical interpretation on the content of current literature on the subject.

V. A sufficient vocabulary should be acquired to permit the individual to converse intelligently about biology and subjects related to it.

VI. Cognizance should be made of the fact that the living world exists in a very delicate balance of an interdependence of living things in which each species has a regulatory influence upon others.

VII. A knowledge of typical life situations of a biological nature should be acquired which will permit the individual to assume his share of social responsibilities, and be the more able to function, physically, mentally, and socially as a desirable member of society.

VIII. There should be such a complete understanding of life that he will appreciate the importance of his place, with that of man, in the organic world.

IX. An ability to observe natural phenomena should be developed so as to understand how living things live, develop, respond, and die.

X. The influence of the environment, both physical and biological, should be presented showing that living things must live in close harmony with this influence to survive.

XI. Sufficient familarity with a diverse number of living things should be developed so as to understand the changes they have undergone in the past and their possible improvement in the future.

XII. Develop the correct attitude toward and a keen appreciation for those life situations which are for his betterment as well as for the group as a whole.

A Tentative List of Specific Objectives for Teaching Biology:

It is difficult to list the exact number of specific objectives for teaching biology. The list could be quite extensive. For an initial report of this type such an extensive list is undesirable. An attempt was made to classify the list of specific objectives into groups or divisions of subject matter. These divisions are not all inclusive. At the end of the list is a division containing a miscellaneous group difficult to classify.

Structure and Function of Living Things

To know the structure of the parts of living things.

To understand the function of these parts.

To understand how seeds germinate and grow.

To acquire a knowledge of life processes of living things,—osmosis, photosynthesis, digestion, assimilation, circulation, absorption, food taking, respiration, elimination, etc.

To understand the function of a cell.

The Response of Plants and the Behavior of Animals

To understand how plants and animals respond to types of stimuli.

To know the general structure of the nervous system of man.

To develop the ability to differentiate between trophism, instinct, reflex, habits, intelligence.

To develop the correct attitutde toward intelligent behavior.

To know how the body is controlled.

The Continuation of Life-Reproduction

To know that all life originates from life.

To know the different types of asexual reproduction.

To know the life histories of the fern—the moss.

To know the life histories of the more common representative animals.

(Continued on next page)

To understand the sexual reproduction of plants.

To develop the correct attitude toward sex education.

To know the hygiene of reproduction.

Inheritance of Characteristics—Heredity

To know that there is a similarity of parent and offspring.

To know the nature of heredity.

To understand the principles for the improvement of living things.

To develop the correct attitude toward legislation relative to eugenics.

To develop an interest in euthenics.

To develope an attitude of appreciation for the laws of heredity.

To know that certain characters (acquired) are not inherited.

To develop an attitude of appreciation for the continuity of the germ plasm.

To know that changes in form takes place slowly.

The Record of Living Things of the Past

To understand the principles of evolution.

To know that living things do change from one generation to another.

To know that the changes may be for the better or for the worse.

To develop an appreciation for the fact that the more complex forms have evolved from the similar forms.

To know that living things have left records of their forms in many different ways.

The Groups of Living Things

To acquire the knowledge of the scheme of classification of animals.

To know the important major groups of living things.

To become interested in the study of the groups of living things as an avocational interest.

To develop a scientific attitude toward classification.

To develop the ability to recognize members of the more common groups of planimals.

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COMBINED SCIENCE COURSES

(Continued from page 9)

dicting the use of automobiles, his scientific attitude should be improved. Even a brief study of the lives of Priestley and Lavoisier, of Davy and Pasteur, of Madam Curie and our own Dr. McCollum cannot fail to develop in our students a profound respect for the scientific method. The history of physics offers equally good examples — Archimedes, Galileo, Newton, Maxwell, Faraday, Henry, Coolidge, and Millikan. Certainly our students should know something about the contributions these men have made to modern civilization.

In our combined course the teacher has an excellent opportunity to emphasize the importance of science. We do this, both by discussing the topics presented in the text and by assigning oral reports which the students volunteer to give, after they have done the necessary reading.

The following summary will give some idea of the ground covered in this special course:

SECTION A. CHEMISTRY

1. The A-B-C's of the language used by chemists. Elements, compounds, mitures, physical and chemical changes, atoms, molecules, and the significance (but not the ability to use) symbols, formulas, and equations.
2. Oxidation.
   a. The atmosphere, including the properties and uses of its ingredients.
   b. Fire and fuels.
3. Acids, bases, salts, and neutralization.
4. The relation of chemistry to health.
   a. The foods we eat and the water we drink.
   b. Drugs, poisons, and cosmetics.

(Continued on next page)

5. Clothing and cleaning agents.
6. Building materials.
7. Metals and alloys.

SECTION B. PHYSICS

1. Some applications of the molecular theory.
   a. Molecular motion: Diffusion, osmosis, evaporation.
   b. Molecular attraction: Elasticity, tensile strength, viscosity, surface tensions, capillarity.
2. Sound.
3. Light.
4. Heat.
5. Mechanics.
6. Magnetism.
7. Static electricity.
8. Current electricity.
   a. Electric cells and batteries.
   b. Electrical measurements.
9. Electrical communications.
   a. The telphone.
   b. Wirless telegraphy.
   c. Radio.
   d. Television.

This outline does not give a clear picture of this course. Most of the topics listed will be found in the standard texts. In reality, however, there are marked differences. To stimulate and hold the interest of the pupils, the everyday uses of science are presented. In the chemistry section the chapters on foods, drugs, cosmetics, clothing, cleaning agents, and building materials will illustrate this point. In the physics section this difference is most noticeable (1) in the treatment of the molecular theory, (2) in the chapter on "electrical communication," and (3) in the omission of all problems, formulas, and applied mathematics.

After all, success or failure in pre-

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TEACHER'S PROTECTIVE ASSOCIATION

E. W. Powers

In the November, 1935 issue of the Illinois Chemistry Teacher appeared a descriptive article about the Teachers' Protective Association. That article stated the aims of the association, the underlying studies upon which the non-profit association was formed, the dues and membership, the officers, and the steps taken up to that time. The editor solicited a note from the executive secretary, E. W. Powers of Bloomington, as to the progress made up to this time.

It appears that six Divisions of the Illinois State Teachers Association have endorsed the movement, namely, those meeting at Champaign, Joliet, Carbondale, Springfield, Moline, and Dixon. It seems possible to reach only about two Divisions in the fall and two in the spring owing to conflicting dates of the meetings. All Divisions to which the objectives of the association have been presented thus far have given their endorsements. The Illinois City Superintendents' Association, which had its meeting in November, 1936, took similar action.

Over nine hundred members are now enrolled and the Advisory Board has swelled to thirty-seven, including educators from the University of Illinois, two teachers colleges, city superintendents. county superintendents, high school and elementary school principals, and classroom teachers.

The Illinois Wesleyan University, after five months study, unanimously adopted, through committees of trustees and faculty, the pension-annuity offered by the Illinois Teachers' Protective Association and issued by the Great State Life Insurance Company as the basis of its retirement income plan.

Besides the retirement income contract, the Association has secured a last illness and burial fund contract and a special life insurance policy for teachers.

Further information may be secured through the Executive Secretary, E. W. Powers of Bloomington, Illinois, or President Monroe Melton, Superintendent of schools, Normal, Illinois.

FUR TANNING

(Continued from page 16)

is drying if a soft pliable skin is wanted. The time for working the skin is also quite important. It should be started when the skin, upon being folded, shows a white streak in the fold. If the skin feels dry and hard or if it is wanted more pliable, it may be oiled on the flesh side with sulfonated neats foot oil and then pulled back and forth over a smooth edged timber until the oil is worked in and the fiber becomes as flexible as desired. An ammonia, soap, and oil emulsion may also be used for oiling.

To make the best quality fur and to insure that none of the hair will come out, the green pelt should be given a preliminary ash treatment before salting This treatment consists in covering the furs inside and out with dry hard wood ashes and leaving them at least six months or until ready for tanning. After being treated with ashes, allow five to eight days for the acid salt process using the maximum of acid recommended. From then on the process is as previously described.

Alum Process

Another process used commercially for tanning furs has some advantage over the one just described because it is partly a vegetable and partly a mineral process. The process consists of applying to the flesh side of the hide a mixture of the following composition:

Aluminum sulfate
Sodium chloride
Gambier
Rye flour (or wheat flour)
Water (distilled or rain)
Glycerine or olive oil

The aluminum sulfate is dissolved with the sodium chloride in a small amount of water. The gambier is boiled until it is dissolved and then the two solutions are mixed. The rye flour is made into a thin paste with lukewarm water, the oil or glycerine is added to the flour paste, and finally the whole formula is mixed together. When the mixture is to be used, enough flour should be added until a thin paste results. The oil or glycerine is added only

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DEMONSTRATION VS. LABORATORY

(Continued from page 12)

commonly measured, when introduceed to the study of college chemistry by the lecture demonstration method."

4. "On the same basis it seems reasonable to conclude that the students of lesser ability profited relatively more by the introduction through lecture demonstration than did the students of greater ability."

Such investigations, while undoubtedly of value in our attempt to analyze and understand the problem, indicate to me that a great many things influence the benefits obtained by either method. The differences in the type of student and teacher, equipment and type of experiments used, probably have a large influence. Consequently, it is difficult to draw any clear-cut conclusions as to which method is best.

COMBINED SCIENCE COURSES

(Continued from page 21)

senting this subject will depend upon the teacher. We use the lecture-demonstration method. The pupils like it, and so does the teacher, for the following reasons. There is no set time schedule. There are no college requirements to be met. The teacher is free to select his own topics, to demonstrate his pet experiment and, in short, to use all his energy in teaching and inspiring his pupils.

SUMMER SCHOOL COURSES

(Continued from page 15)

and organic chemistry. Three quarters unit graduate credit will be given those who meet with Professor D. B. Keyes four times a week in this course.

At present an effort is being made to have certain graduate courses in chemistry meet on Saturday mornings during the school year 1937-38, in order to make it possible for secondary school teachers living within reasonable distance from Champaign-Urbana to attend. No definite decision concerning this movement is available at this time.

TOBACCO MOSAIC

(Continued from page 3)

generalization. In view of the properties which this protein possesses, the borderline between the living and the non-living tends to become non-existent, for, although the protein possesses properties which have been regarded as characteristic of living things, such as specificity of host range and the ability to reproduce and to mutate, it is nevertheless a protein molecule and as such may be regarded as non-living. It is possible that by virtue of its size, it is enabled to possess sufficient organization within the molecule to endow it with such properties. As such, it would represent a link between the type of organization within the atom or molecule with which chemists have concerned themselves and the type of organization within the cell with which biologists have been concerned. In any event, it now appears possible to list protein molecules along with living organisms, such as bacteria, fungi, and protozoa, as infectious disease-producing agents. Infection may be regarded as the introduction of a few molecules of a virus protein into a susceptible host. These few molecules appear to have the ability to direct the metabolism of the host so that it produces not normal protein but more of the virus protein. In this respect the protein possesses a property somewhat similar to that of the mammalian organizers, or perhaps to that of genes. Disease may be regarded as the disruption of normal metabolism caused by the production of virus protein. It is possible that, during the production of millions of molecules of a given virus protein by a host, occasionally a molecule having a slightly different structure might be produced. The prouction of such a molecule and its subsequent multiplication would give rise to a new virus strain and thus account for the phenomenon which we call mutation. Whether one regards this protein as living, as non-living, as a gene, as a super-catalyst, as an organizer, or as a pathological protein, its study is most fascinating.

FUR TANNING

(Continued from page 22)

if the skin is preferred soft or if the skin is quite hard.

The paste of the above composition is applied to the flesh side of the hide about one-eighth of an inch thick. For a medium weight or heavier skin it is necessary to apply two coats of the paste one day apart before hanging the skin up to dry. The first coat is scraped off before the second coat is applied. The skin is then washed with laundry soap on the flesh side or dipped for thirty minutes in a borax solution. Before the skin is dry, it must be pulled back and forth a number of times over a smooth stick like shining a shoe, in order to make the skin pliable. The best time for this is when the skin appears white along the place it has been folded. Usually an alum tanned skin does not need oil, but should the skin be hard and dry and require oiling sulfonated turkey red oil or glycerine may be applied. The pliability of the skin depends upon repeated working while the skin is drying out. A solution of soap or stearic acid is recommended for alum tanned fur as either of these fixes the tanning materials more permanently.

Deodorizing Furs

Some furs as they come from the animals have an odor which does not always leave in the tanning process. Such furs after tanning may be deodorized by dipping in a solution prepared as follows: Eight pounds of tanner's soap or any good bar soap chipped fine is dissolved in four gallons of water. Then seven pounds of sal soda are added and the mixture is boiled until the soap and soda are disssolved. While the solution is hot, 1 1-2 ounces of borax and one ounce of sassafras are added. After cooling, the solution is ready for use. Furs should not be dipped into this solution until after they are tanned.

Dyeing the Furs

If the furs are to be dyed another color, either a chromate or acid dye may be used successfully. The chromate dye will produce a fast and lasting color in all shades except black. An acid dye will produce a much better black color.